

Recent Detector R&D Progress

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AEM – 14 April, 2014

- Detector R&D overview
- Recent results from:
 - 3-dimensional ASICs
 - Liquid Argon
 - MKIDs
- Progress in test facilities
 - MilliKelvin
 - MTest
 - MCenter
 - MTA Irradiation

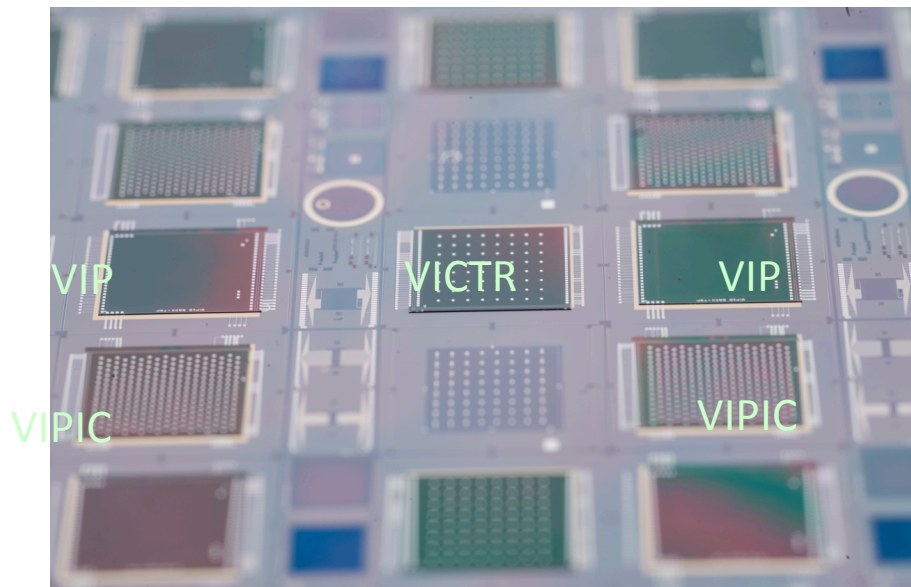
The Fermilab Detector R&D Thrusts

- **Calorimetry/photodet.** (HHCAL, heavy glass, SiPM, MCP)
- **Liquid Argon** (Purity, HV, Scint eff., solid Xenon)
- **High rate tracking** (65 nm, 3D ASICs)
- **Cosmic Frontier** (CCD's, MKID's, CMB)
- **DAQ/Trigger** (CAM trigger, ATCA, rad-hard Optical)
- **Facilities** (MTest, MCenter, High rate tracking, cryogenics, ASIC design, Thin-film, etc.)

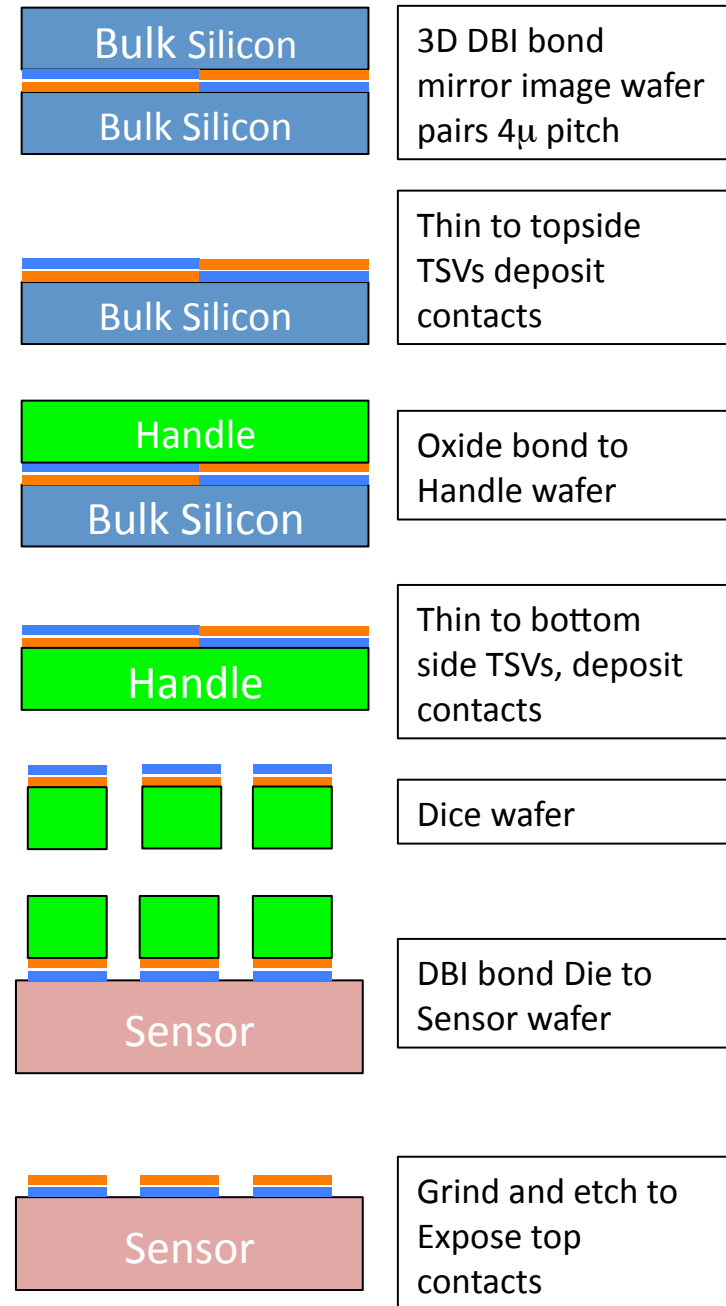
3 Dimensional ASICs

- Recently received the first 3D chips oxide bonded to sensors
- 3 tiers of bonded devices. Two electronics and one sensor tier. Sensor fab'ed by BNL – 500 micron thick
- Final chips are 25 microns thick, DBI bonded to the sensor on the bottom and contacted by Through-Silicon-Vias (TSVs) on the top.
- This technology could revolutionize the design of pixel arrays. Testing will start soon.

(thanks to Gregory Deptuch, Ron Lipton and ASIC team + Ziptronix + Tezzaron + BNL + SLAC + Cornell)



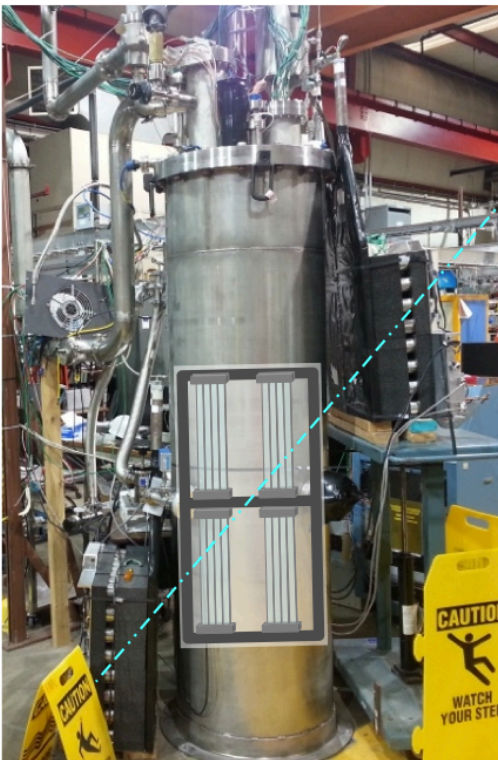
R. Lipton



Liquid Argon Detector R&D

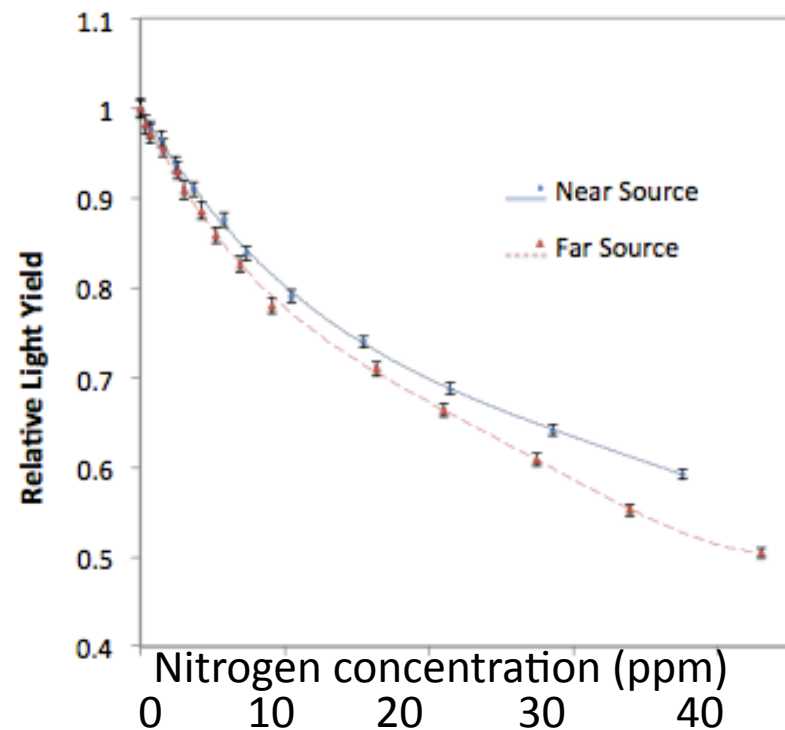
in transition from development of tracking (charge collection) to studies of light production, propagation and detection in a new cryostat with 2 m argon depth

LBNE Light Test in new Cryostat (Tall Bo)



Plastic bars coated with wavelength shifter, readout with SiPMS - used to assess assembly techniques for light bars

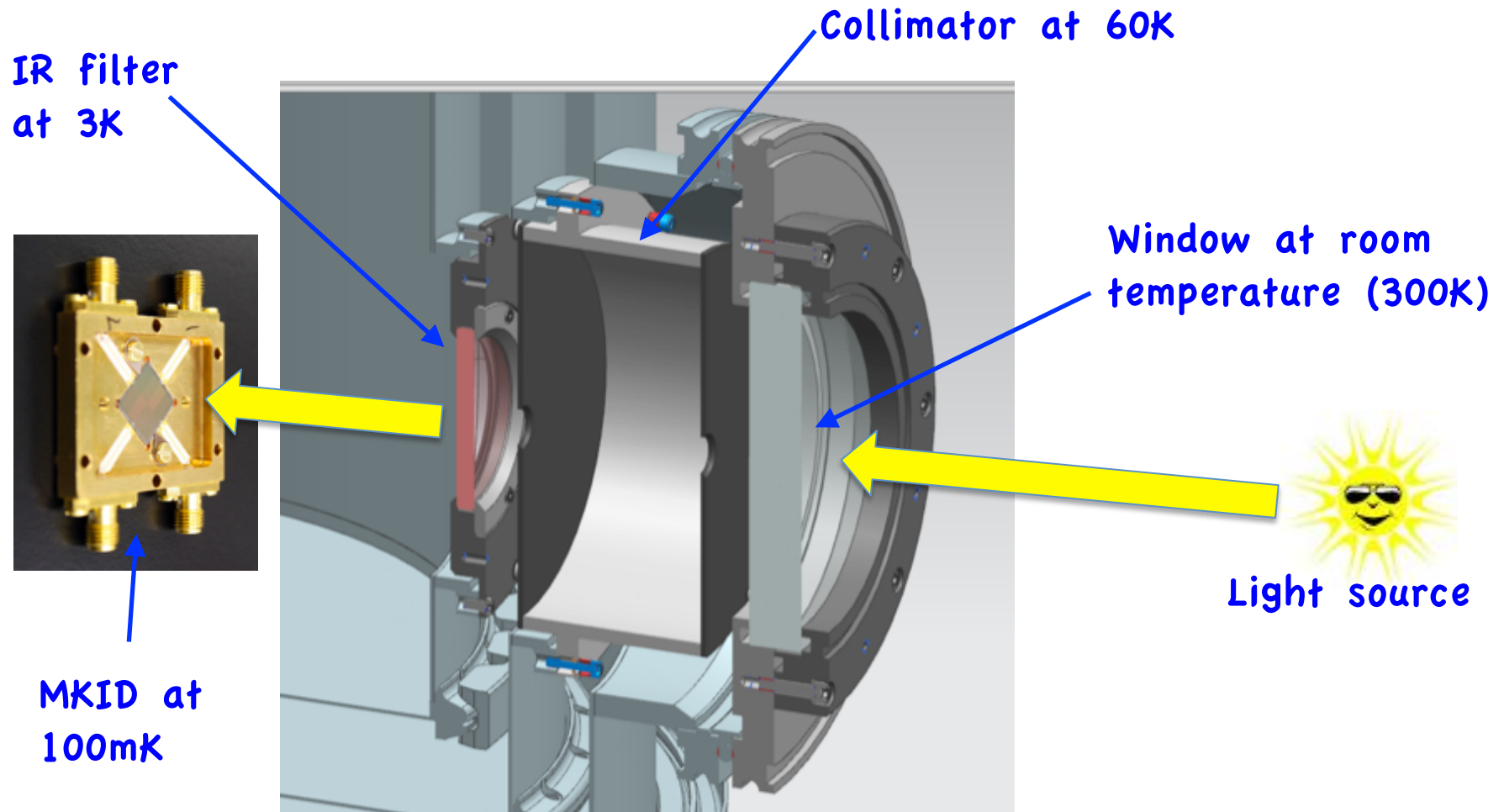
light yield as a function of Nitrogen concentration for polonium source at two distances from PMT. The divergence of the two lines is attenuation.



Absorption by Nitrogen: JINST 8 P07011

The Effects of Methane: JINST 8 P12015

MKID R&D : “Microwave Kinetic Inductance Detector”

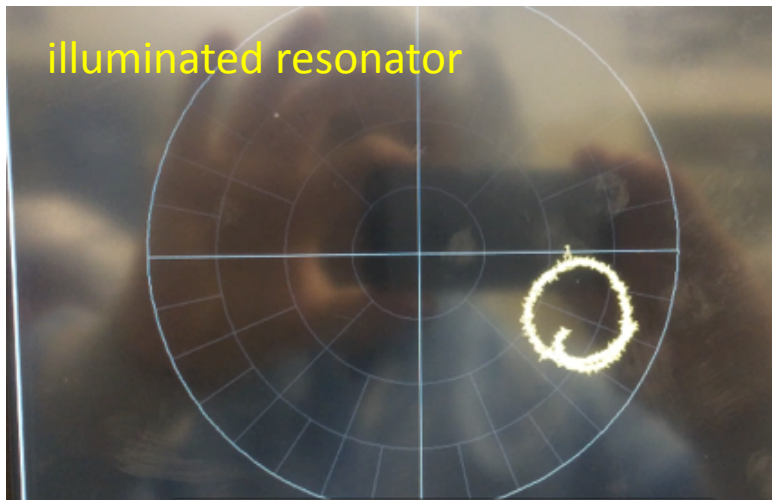
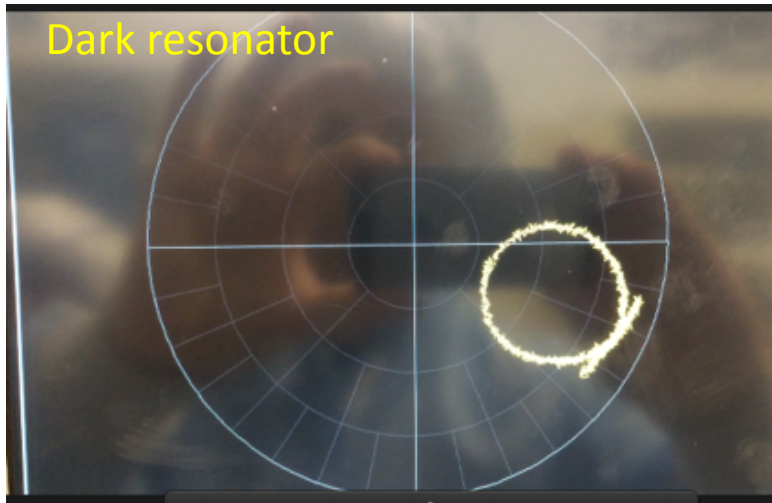


Get light into a sensor at 100mK... with only a thermal budget of 0.5uW. Succeeded at FNAL last week. (design by Greg Derylo)

MKID RF Q versus I diagram



Optical window
installed.



Resonance
frequency shifts
and smaller Q
(smaller circle)
when light is ON.

Thanks to Donna Kubik, Jorge Montes, Kevin Kuk

MTest is bustling with activity (as usual)



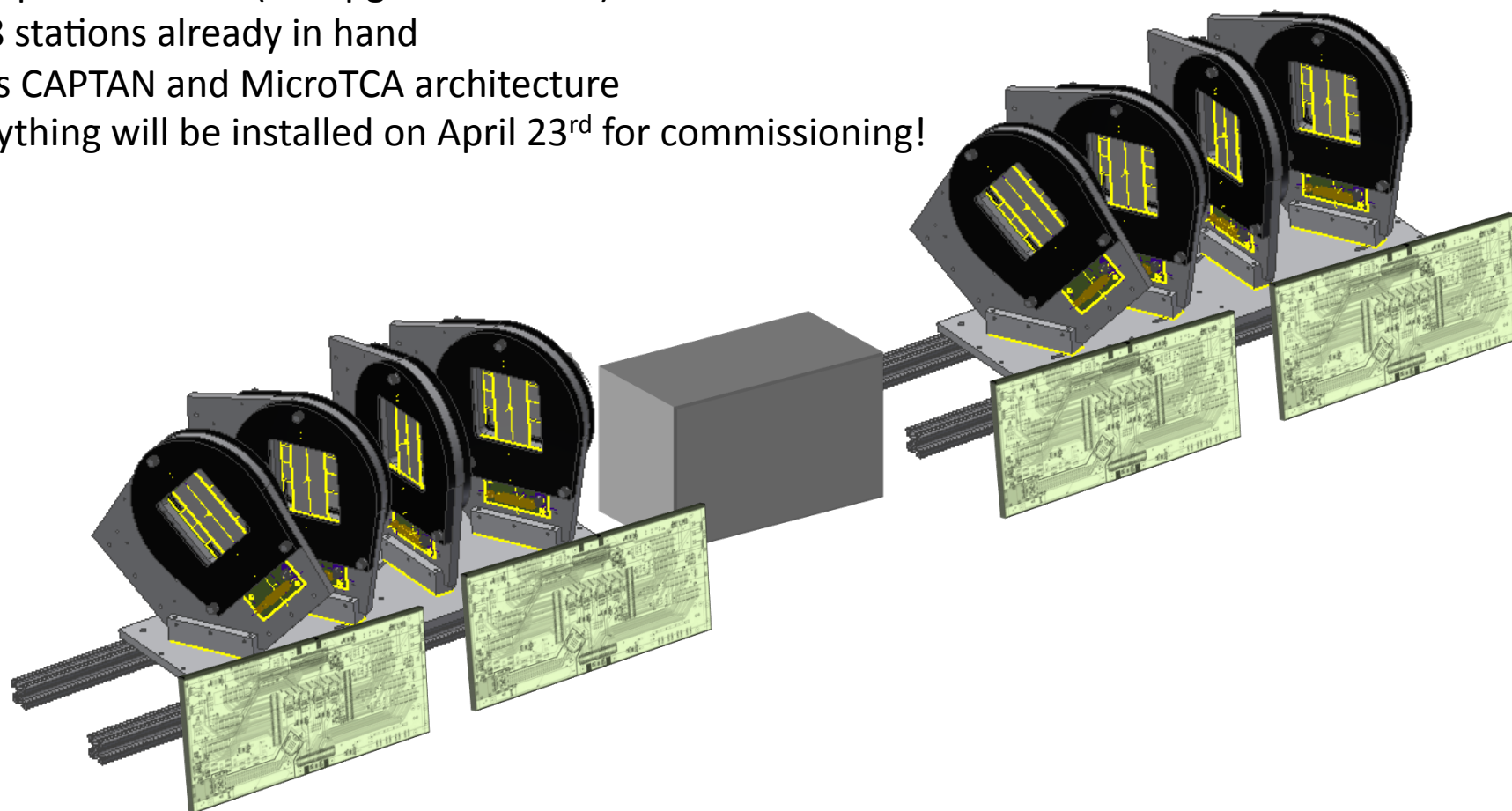
Apr 9 - Apr 15	T1041 CMS Forward Calorimetry	Primary	24	6.2	Bilki
Apr 16 - Apr 22	T1041 CMS Forward Calorimetry	Primary	24	6.2	Bilki
Apr 23 - Apr 29	T992 Radiation-hard Sensors for the SLHC	Primary	0800-2000	1-A	Rivera
	T1042 Muon g-2 straw tracker	Secondary	12 Day	2-B	Rominsky
	Make-up slot		12 Night		
Apr 30 - May 6	T992 Radiation-hard Sensors for the SLHC	Primary	0800-2000	1-A	Rivera
	T1042 Muon g-2 straw tracker	Secondary	12 Day	2-B	Rominsky
	Make-up slot		12 Night		
May 7 - May 13	T1049 ATLAS large scale TGC	Primary	12 Day	2-B	Stelzer
	Make-up slot		12 Night		
May 14 - May 20	T1049 ATLAS large scale TGC	Primary	12 Day	2-B	Stelzer
	Make-up slot		12 Night		
May 21 - May 27	T1049 ATLAS large scale TGC	Primary	12 Day	2-B	Stelzer
May 29 - Jun 3	T979 Fast Timing w/Cherenkov Counters	Primary	12 day	2-A	Albrow
Jun 4 - Jun 10	T1015 ADRIANO (for High Energy)	Primary	12-Day	2-B	Gatto
Jun 11 - Jun 17	T1015 ADRIANO (for High Energy)	Primary	12-Day	2-B	Gatto
Jun 18 - Jun 24	T1015 ADRIANO (for High Energy)	Primary	12-Day	2-B	Gatto
	Make-up slot		12 Night		
Jun 25 - Jul 1	available		12 Day		
	Make-up slot		12 Night		

Need better parking lot !

A few slots are open in Summer

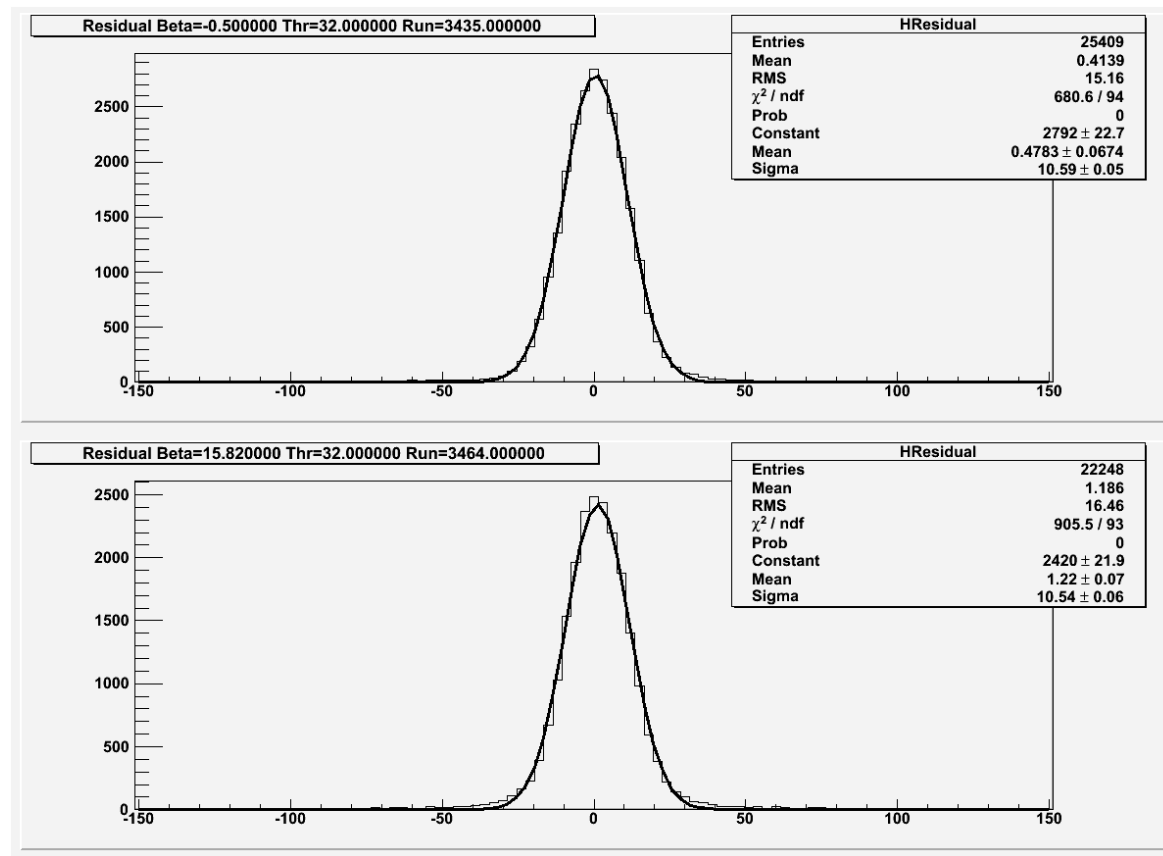
New Silicon Strip Telescope Overview

- Computing Division ESE has built an additional telescope to supplement the pixel one.
- 8 stations of 2 strip planes each measuring X and Y with a 45 rotation capability for disambiguation
- Total coverage is about 4x4 cm²
- Strip pitch is 60um (D0 upgrade sensors)
- All 8 stations already in hand
- Uses CAPTAN and MicroTCA architecture
- Everything will be installed on April 23rd for commissioning!



Test Beam results for Silicon Strip Telescope

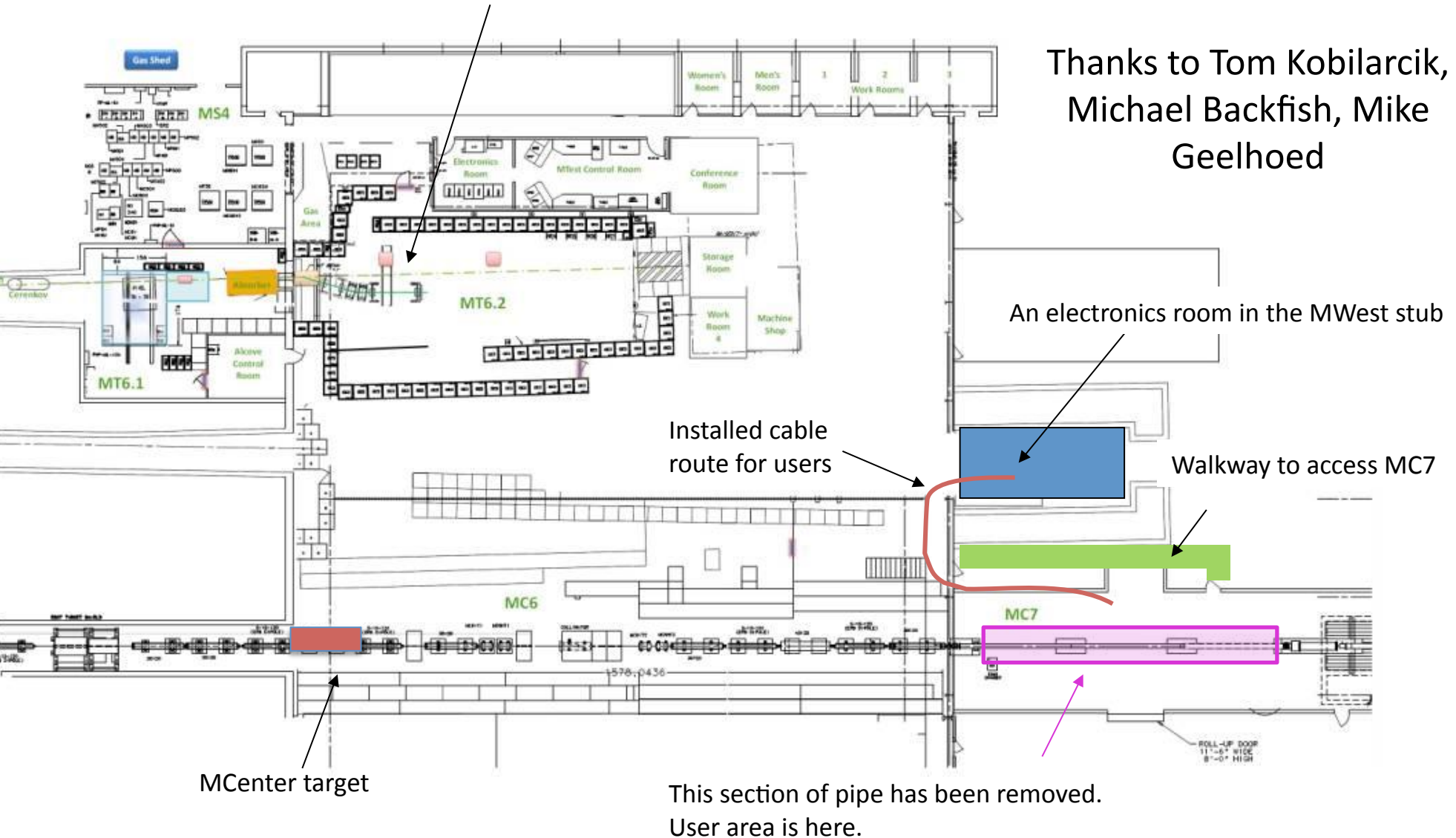
- 2 strip planes were tested in January inserted in the pixel telescope for tracking
- 99.8% efficiency at different angles
- Measured residuals $\sim 7\mu\text{m}$ (already telescope subtracted) at 0 and 15 degrees
- With 8 station expected error on the detector under test of $\sim 2\text{-}3\mu\text{m}$!!



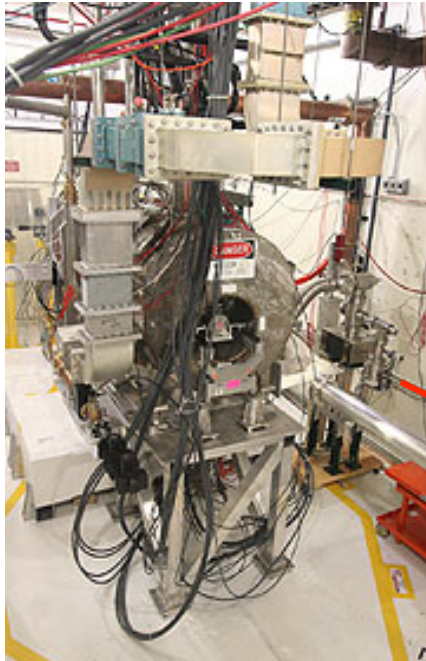
MCenter becomes a Test Beamline!

Tertiary beam moved
to MC7

Thanks to Tom Kobilarcik,
Michael Backfish, Mike
Geelhoed

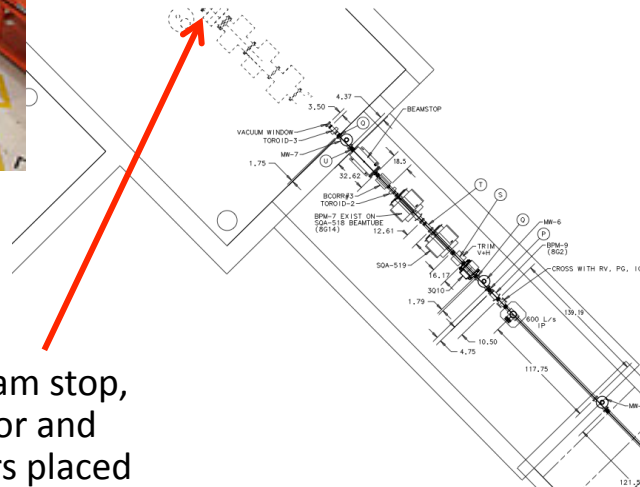


New Detector R&D Irradiation Capability at MTA?



MICE cavity to be tested within its solenoid

- The MTA experimental hall has now accepted beam. (400 MeV protons)
- It is possible that we will be able to perform detector irradiation studies there. Safety issues being studied.
- **Flux as high as 10^{14} / hour** in the experimental hall
- First Statement of Work submitted



Stand for beam stop, collimator and detectors placed upstream of solenoid



Directorate

TECHNICAL SCOPE OF WORK FOR THE 2014 FERMILAB MTA DETECTOR IRRADIATION PROGRAM

T-992: Appendix I

MTA Irradiation of Radiation-Hard Sensors for the SLHC

5 March, 2014

